N.A.C.A. BULLETIN

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EDITORIAL DEPARTMENT NOTE

Of late there has been growing emphasis in the literature on cost control that "costs are controlled at the source," meaning that control rests at the point where decisions are made on the use of material, application of labor, and use of services. This is the point where we find the supervisor and the key man in cost control. It has long been recognized that supervisory incentive plans had great possibilities for cost control and improved performance, but the difficulty of developing a simple and reasonable base for incentive payments has delayed the spread of such plans. In the first article of the issue there is described a supervisory incentive plan which is simple yet has proven practical.

J. J. BIGGE, the author of this article, is a native of Michigan, who received his advance education at the Universities of Detroit and Notre Dame and the Harvard Business School. For nine years following his graduation from Harvard he served as an executive of the Panyard Piston Ring Co. of Muskegon. This was followed by six years as Assistant Treasurer and Assistant to the President of Campbell, Wyant & Cannon Foundry Co. Last fall he joined Brown & Bigelow of St. Paul as Factory Comptroller.

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The effect of changes in volume, prices, costs, and mixture of products on profits is a subject of interest and importance to all industrial accountants. The second article in the issue provides a clear-cut exposition of the use of the marginal income ratio to calculate the effect of these changes on net profits.

CHARLES H. GLEASON is especially well qualified by experience to write on the subject. As Manager of Cost Control and Cost Analysis of Sylvania Electric Products, Inc., he is responsible for coordinating manufacturing cost control and production control in his company's twenty-two plants. Prior to joining Sylvania in 1943, Mr. Gleason had been connected with the Great Western Sugar Co. in cost analysis work, with Cities Service Co. as Office Manager, with P. H. Whiting & Co. as Partner, with the Trundle Engineering Co. as Management Engineer and with the Larkins Industries as Operating Vice President. Mr. Gleason has been a frequent speaker before accounting groups on cost control, cost analysis, and related subjects.

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For a short article, our third article covers a lot of ground and outlines a practical procedure for the application of punch card methods to property and depreciation accounting.

JOSEPH G. SIDAK, author of this article, is Tabulating and Payroll Supervisor of Solar Aircraft Co. of Des Moines. A native of Nebraska, he received his education there, and after graduation was employed by the city of San Diego, Calif. as Cost Accountant. He joined Solar Aircraft and served as Assistant Chief Cost Accountant before taking over his present duties as Tabulating and Payroll Supervisor.

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JULY 1, 1947

AN INCENTIVE PLAN FOR SUPERVISORY PERSONNEL

by J. J. BIGGE, Factory Comptroller,
Brown & Bigelow,
St. Paul, Minn.

INCENTIVE plans of various kinds have been used for years in all types of industries. These have all had a common aim; that of increasing production and at the same time reducing and stabilizing the unit cost of the operation or product. The success of these plans is amply proven by American production records and the high average earnings of American workers engaged in manufacturing. By the same method, stabilization of unit costs and increased absorption of burden through greater output have resulted in lower product selling prices in a highly competitive market.

Piece Work and Bonus Plans

The most common type of incentive plan is, of course, piece work. In effect, this system puts every employee in business for himself, with worth-while rewards for extra effort, dexterity, skill, or carefulness. It is also used as a group plan, where the piece rate is established for work requiring more than one employee to complete. There are other variations of piece work systems, but they mainly have the same characteristic; that of paying the employee for the quantity and quality of work he produces, rather than for the length of time spent in the plant.

Another plan used to promote greater effort, increase carefulness, or reduce waste is a bonus paid periodically for savings resulting from better department or plant performance. A characteristic of these plans is that the amount received by each employee is usually influenced to some extent by the accomplishments of others, either departmentally or plant-wide; in other words, the individual employee usually has no direct control over all the factors influencing the amount he receives.

Incentive plans generally are designed with the production worker in mind; they usually do not include any employee above the status of a "working foreman" or group leader. The true foreman or supervisor is customarily paid either a fairly high hourly rate or a salary, which ordinarily does not change (except for periodic reviews) regardless of the efficiency or inefficiency of his group, section, or department. Consequently, he does not

have the day-to-day goal of greater accomplishment which his superiors would prefer; he can see no immediate financial benefits through extra effort on his part.

Supervisors Are Key Personnel

Since the success of any production betterment plan or cost reduction program depends to a considerable extent upon the cooperation and enthusiasm of the supervisors, some forward-looking concerns have developed and are using incentive plans for their supervisory personnel. These plans are based on definite performance factors and should not be confused with bonuses paid at semiannual or annual periods determined by expediency, tax rates, or custom.

Better over-all plant performance is, of course, the aim of the plan, and has the advantage of keeping all supervisors alert and working to improve conditions generally. The initial step is, therefore, to set aside a fund which management considers to be a fair and reasonable reward for meeting satisfactory standards and which would insure the company's making its expected profit.

Characteristics

Supervisory incentive plans should have four major characteristics in order to be satisfactory. These are as follows:

1. The plan should be based on definite performance factors which can be accurately compared with standards set up for this purpose.
2. These factors and their influence on earnings should be fully understood by the supervisors.
3. The amount which can be earned under the plan should be sufficient to induce the supervisors to put forth their best efforts.
4. Payments should be made promptly and regularly, without too great a period between the time the extra work is done and the date the distribution is made.

Performance Factors

The performance factors can be selected to fit any kind of manufacturing business and usually include such items as increased volume, reduced scrap, and decreased manufacturing cost. Each of the factors is compared with performance standards set up,

and usually each factor is independent of the others. Additional factors may be added to fit the particular problems of a business.

The *volume* factor, which in the above list would constitute one-third of the amount earned, can be a simple comparison of output (in units, gallons, tons, or any other suitable measure) with a standard satisfactory to the management and determined by past performance or plant capacity. An output exactly equal to the standard would then pay 100 per cent of the amount set up for that factor; an increased output would pay proportionately more in direct ratio to the increase, and vice versa, until, at a break-even volume point, such as 60 per cent, no bonus would be paid.

The *scrap* factor, which might constitute another third, is also a comparison of actual scrap percentage with the standard set, with an additional 5 per cent bonus, for example, being given for each one per cent reduction below the standard; but no payment on this factor is made if the standard per cent is exceeded.

The *cost* factor, the final third in the list, is a comparison of actual performance with the standard, usually a budget. Here again, for each one per cent reduction below standard costs, an additional 5 per cent can be added to the amount to be distributed. It is necessary, however, as in the case of lowered volume, to reduce the amount paid more rapidly if costs exceed the standard, eliminating any payment if this excess should reach the break-even point in company operations.

The factors used can be outlined in an easily understandable manner and explained to the supervisors so they will all know just how the earnings are calculated and how their individual efforts can influence the amount they will receive. This point is important in order to keep them doing their best as well as to avoid misunderstanding when the amounts distributed are less because of poor performance.

Also, periodic reports should be made to the supervisors at least weekly, or if possible, daily, showing their performancce in comparison with the standards. They are then in a position to concentrate their efforts on any bad condition which is adversely affecting their earnings.

Bonus Earnings and Payments

The amount set aside for the plan should be sufficient to make it worth while; possible bonus earnings of approximately 25 per

cent of the base salaries usually are satisfactory. Payments of the amount earned should be made promptly and regularly, on a monthly basis if possible. Long intervals between payments cause the supervisors to lose interest in the plan, and irregular distribution dates create questions and dissatisfaction.

Point System for Extra Incentive

Since ordinarily the plan is based on plant-wide performance, it might appear that some participants could coast along on the efforts of the others, or that there would be little reward for outstanding individual effort. This, however, can be taken care of through a point system, by which each participant is allocated a definite number of points, on which the distribution is based. The value of each point would be determined monthly by dividing the actual incentive plan earnings by the total number of points allocated to the participants. The number of points of each supervisor would be reviewed monthly and an increase given for outstanding performance.

Plant-wide performance is suggested because of the difficulty sometimes found in fixing responsibility for scrap. Furthermore, by having the plan based on plant-wide performance, any supervisor attempting to coast along will be prodded into action by his associates, thus making the job of top management that much easier.

Mechanics of the Plan

To illustrate the actual mechanics of the plan, the following hypothetical case is given. The John Doe Manufacturing Company has a capacity of 100,000 units per month of its product. With a cost of $10 per unit mostly direct labor and overhead, the break-even point is 60,000 units per month. Scrap averages 6 per cent and production is running 70,000 units per month. The supervisory staff consists of 10 general foremen, 20 foremen, and 40 assistant foremen. The combined salaries of these supervisors are $28,000 per month. The standards set up were 70,000 units for volume, 5 per cent for scrap, and $9.90 for cost. It was determined that the amount set aside for the monthly bonus, if the standards were exactly equalled, would be $7,000. Initially the points were divided 10 to each general foreman, 8 to each foreman, and 6 to each assistant foreman, making a total of 500 points

and making the value of each point $14 with operations at standard. During the first month of operation they produced 70,000 units at a cost of $10 per unit with 6 per cent scrap. They therefore received their volume bonus in full amounting to one-third of $7,000 or $2,333. No payment was made on the scrap factor, but a 50 per cent payment was made on the cost factor amounting to $1,167. The total bonus was therefore $3,500 or $7 per point.

Summary

It is claimed for this plan that it is workable, and that it has been used successfully. It is relatively easy to sell to management as the additional compensation is paid from part of the profits which the operation of the plan provides. It is self-policing. Finally, it increases the morale of the supervisory staff and may mean the difference between having a foremen's union and no foremen's union.

COMING ARTICLES

In the *N. A. C. A. Bulletin*, July 15, 1947

Concepts of Cost, Past and Present
by Theodore Lang

Making the Office Pay a Profit
by P. A. Lawrence

Organization for Cost Reduction
by Maitland A. Smith

THE PROFIT-VOLUME RELATIONSHIP

by CHARLES H. GLEASON,
Manager, Cost Control and Cost Analysis,
Sylvania Electric Products, Inc.,
New York, N. Y.

PROFIT-volume relationship is the effect that changing volume, cost, price, and mix of products have on profits. Indications are that the best industry can expect in the future is a reasonable return on capital investment. To do better than the average, a company must either have some special advantage over its competitors or work unceasingly to convert potential profits into actual profits. Since special advantages rarely last for long, the safest way to insure a leading place in the field is to know how to uncover unrealized profits and convert them into actual profits.

Although management cannot be the arbiter of which products or models the public will buy in a free competitive market, it should know which products or models carry the most profit margin, which the least profit margin; the effect a proposed reduction in sale price will have on profits; the effect changing volume or mix of products will have on product costs and profits; the break-even point of operations; and the effect of expected increases in wages or other operating costs. Knowing these facts, able management will endeavor to direct policy so as to realize, as nearly as possible, the mix and volume, which will mean the maximum profits from utilization of plant and equipment.

When the question of plant expansion is being considered, in order to take on a new product or increase production of present products, the knowledge of profit-volume relationship may indicate that certain items could be eliminated in favor of the new product, or that increased production of the other items is possible, with a net gain in over-all company profits and without an increase in permanent investment.

The responsibility rests on the controller and cost accountant to provide management with current, accurate, and intelligible statements showing these vital profit factors of the business. As a corollary, the controller and cost accountant must understand the "laws of costs and profits" and be equipped with the best existing technique for analysis and profit projection.

Fixed and Variable Costs

To get a clear picture of the cause and effect on profits of changing volume, price, and cost, we must start with an analysis of the cost of the products we sell and of our selling and administrative expenses. If all manufacturing, administrative, and selling costs were clearly defined variable costs,—i.e., costs that vary directly with changes in production or sales volume—the problem of determining profits at any level of operations, or mix of products, would be simple. Our profit margin for each product would always be the same percentage of the sales dollar, because costs per unit would be the same at all volumes of production or sales.

However, just as soon as we inject into our costs any items of fixed expense—i.e., costs which do not of themselves change with changes in volume or activity, but change through the passage of time—we are immediately faced with the fact that we have a different cost and profit at different volumes of production or sales. When we further complicate our problem by including costs which are neither wholly variable nor wholly fixed, but have elements of both—i.e., semivariable costs—we have what must seem to many an insurmountable problem of costing and profit projection. As with most problems, however, when we get down to fundamental causes and break them down into their elements, we find that they are neither beyond our understanding nor our ability to solve.

Analysis of Manufacturing Costs

In most industrial companies, manufacturing costs represent by far the largest part of total operating costs. They change with every change in volume and, consequently, have the most pronounced effect on the profit picture. Hence we must first determine the breakdown between variable and fixed costs, i.e., the ratio of variable costs to the sales value of production, and the dollar amount of annual fixed costs.

Materials consumed and direct labor used in converting these materials are normally variable costs. Material and labor standards usually exist which enable the cost accountant to determine the cost per unit for these prime costs and the per cent of the sales dollar they represent. Generally, they do not present a problem in either costing or profit-volume determination.

Manufacturing burden, or overhead conversion cost, is a large group of expenses, some variable, some fixed, and some semivari-

able, which require analysis properly to classify and determine either their ratio to the unit sales value of production, if variable, or their cost per month or year if fixed.

Graphic Analysis

Analysis of past operating costs is the logical way to determine whether the account is a variable or fixed cost. The simplest and perhaps the best way to make this analysis is by building a scatter chart on graph paper. Not only will this method classify the account, but it will permit easy determination of the variable expense ratio to production. The process is not complicated and it has the added advantage of presenting a visual picture of the monthly variations during the period being studied.

In order to build a scatter chart, we must first decide on the barometer which will serve best as the base of the graph or measure of production activity. Since our objective is the analysis of profit-value relationship, this base factor must be either the sales value of production or some factor which can be converted into the sales value of production, so that the variable burden cost can be expressed as a per cent of the sales value.

Barometers which meet these requirements of simple and ready availability are:

1. Units of production of each product.
2. Direct labor hours or dollars.
3. Machine hours.
4. Sales value of production.

Units of production, direct labor dollars, and labor or machine hours are generally preferred as barometers when analyzing manufacturing burden or overhead conversion costs; whereas the sales value of production is the preferred base when analyzing administrative and selling expenses.

Exhibit 1 illustrates a scatter graph analysis, which shows the account to be a semivariable expense with a ratio of 3.7¢ expense per direct labor hour, plus a monthly fixed cost of $1,600. In building a scatter chart, the barometer, or control base, should be used as the horizontal base scale of the graph. The left-hand vertical scale, or ordinate, should represent the dollars of expense in the account analyzed.

After the points have been plotted, a medial line should be drawn through the points on the graph to intersect the left-hand

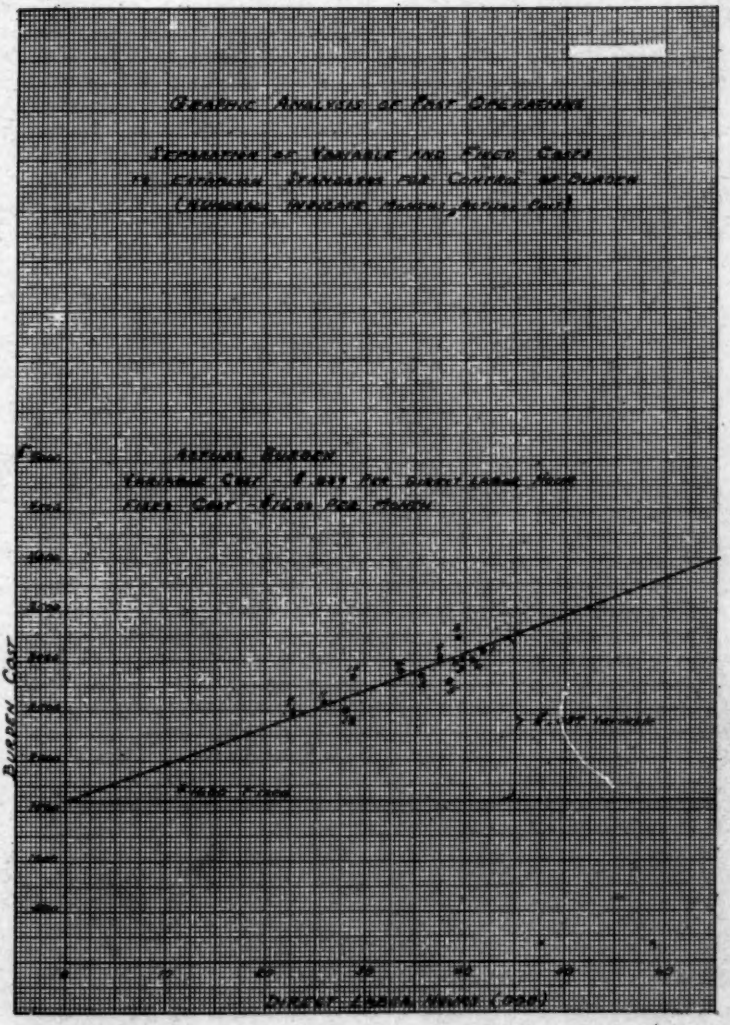

Graphic Analysis of Post Operations
Budget Cost
Direct Labor Hours (000)

Exhibit 1.

vertical ordinate. Visual location of this medial line, or use of the rule of "least squares," is satisfactory for all practical purposes of analysis. Some may argue that one cannot get accuracy in determining a ratio when using a visual inspection for setting the medial line. The obvious answer is that no method will give absolute accuracy in budgeting, cost analysis, or profit determination. The technique suggested here will come as close to perfection as any, without being too complicated.

If the expense is one that is 100 per cent variable and moves in exact ratio to conversion activity or production, the angle of the medial line or hypotenuse will intersect the left-hand vertical ordinate at zero. In an account which is a fixed cost, containing no variable element, the medial line will parallel the horizontal base.

If the account is one that combines both a variable and fixed element, the angle of the medial line, or hypotenuse, will intersect the left-hand vertical ordinate at that point above zero representing the amount of fixed cost in the account. Such an account is illustrated by Exhibit 1.

Determination of the ratio of variable cost to production becomes a simple problem in geometry, since the variable cost represents the angle formed by the medial hypothenuse line and the base line above fixed cost. Variable costs should be expressed as "dollars per base unit" if the base scale represents units of production, labor or machine hours. If the base scale represents labor dollars or sales value of production, they should be expressed as a "percentage of the control base." As an example, if the base in Exhibit 1 were direct labor dollars instead of hours, the variable cost would have been expressed as 3.7 per cent of the direct labor dollars. Fixed expenses should be expressed as dollars per month, year, or other operating period.

Mathematical Analysis

Sometimes the graphic analysis of past operations cannot be used to determine whether costs are variable or fixed, or the ratio of variable costs to plant activity or production; as when we are projecting profit-volume relationship for a new department being established, or when past operating conditions were substantially different from those planned for the future. Here the separation of variable and fixed costs must be done mathematically. Exhibit 2 shows the use of a mathematical formula and a comparative graphic analysis of the same account.

MATHEMATICAL FORMULA

Seperation of Variable and Fixed Costs

to Establish Standards for Control of Burden

(1) To determine the ratio of variable costs to direct labor hours:

Monthly Direct Labor Hours			Indirect Labor Cost
High Volume	60,000 hrs.		$2,820
Low Volume	10,000 hrs.		1,970
Variance	50,000 hrs.	@ $.037	$1,850

(2) To determine the monthly fixed cost:

	Low Volume	High Volume
Total Indirect Labor Costs	$1,970	$2,820
Variable Cost @ $.037 per labor hr.	370	2,220
Monthly Fixed Cost	$1,600	$1,600

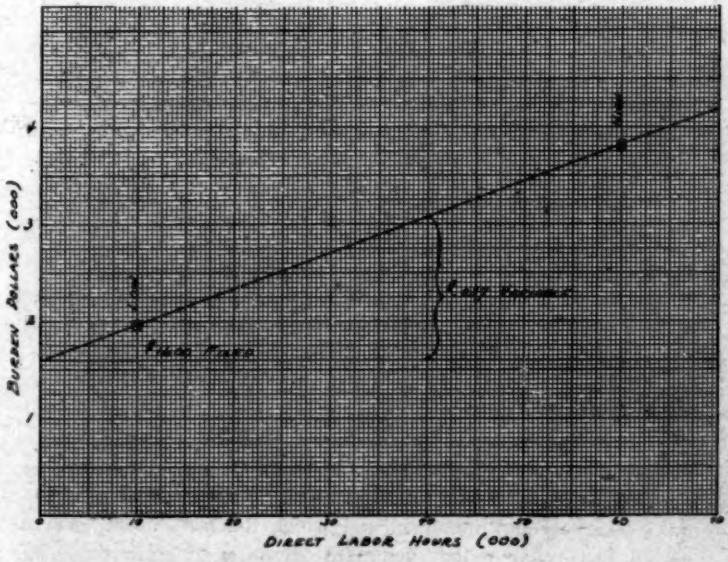


EXHIBIT 2

The mathematical formula calls for setting of a high and low volume of production, or conversion activity, representing the probable maximum range of future operations. The cost at both the low operating level and the high operating level should be estimated, based on known or expected conditions. The quotient obtained by dividing the difference between high and low volume into the difference between high and low expense will be the variable standard for the account. Subtraction of the variable expense from the total expense, using either high or low volume, will give the fixed expense present in the account.

As stated before, our first objective is to classify burden costs as either variable or fixed, determine the ratio of variable costs to the sales value of production, and the dollar amount of monthly or annual fixed costs. With the before-mentioned tools of graphic or mathematical analysis, we can break down each manufacturing burden account into its variable and fixed components, both for the plant as a whole and for each major product. The same technique will give a breakdown of administration and selling cost.

Since the base factor used in each case to determine the variable ratio is itself one which can be expressed directly, or by conversion, as a percentage of the sales value of production, the determination of the percentage of the sales value represented by each variable cost is simply a problem in mathematics.

The Operating Statement

Now that we have acquired our primary tools of analysis and understand how to use them, we are ready to analyze the profit-volume relationship of the company's operations during the past year. This analysis will supply the basis for projecting operating profits for the future and the effect changes in volume, price, costs, and mix of products will have on profits. We shall determine the break-even volume of operations; the effect on costs and profits of an increase or decrease in production volume, or of a major change in the mix of products; the effect of a reduction in sale price; of increased wages or other operating costs; which products carry the most profit margin and which the least profit. These are all facts vital to the successful operation of every business.

Exhibit 3 represents the plant operating statement which has been broken down to show the fixed and variable operating costs, the ratio of variable costs to the sales value of production, and the break-even volume of operations.

TWELVE MONTHS' OPERATING STATEMENT

	12-Month total	Cost Breakdown: Fixed cost	Cost Breakdown: Variable cost, Per Cent	Cost Breakdown: Variable cost, Amount
Sales Value of Production	$6,000,000		100.00%	
Manufacturing Cost				
Materials consumed	$1,200,000		20.00%	$1,200,000
Direct labor	1,500,000		25.00	1,500,000
Departmental indirect labor	186,000	$ 36,000	2.50	150,000
General supervision, production control, engineering, services, etc.	246,000	102,000	2.40	144,000
Occupancy expense	48,000	30,000	.30	18,000
Equipment maintenance	156,000	6,000	2.50	150,000
Process power, gas	66,600	6,000	1.01	60,600
Factory supplies, etc.	22,200	4,200	.30	18,000
Insurance, Federal old age, unemployment, pensions, vacations	229,200	13,800	3.59	215,400
Depreciation	96,000	96,000		
Total manufacturing cost	$3,750,000	$ 294,000	57.60%	$3,456,000
Administrative Expenses				
Salaries and wages	$ 336,000	$ 282,000	.90%	$ 54,000
Occupancy	18,000	15,000	.05	3,000
Communications, stationery, supplies, etc.	24,000	9,000	.25	15,000
Insurance, F.O.A., unemployment, etc.	33,000	27,000	.10	6,000
Depreciation	9,000	9,000		
Total administrative expense	$ 420,000	$ 342,000	1.30%	$ 78,000
Selling Expense				
Salaries, wages, commissions	$ 214,500	$ 109,500	1.75%	$ 105,000
Occupancy	9,000	6,000	.05	3,000
Communications, stationery, supplies, etc.	36,000	6,000	.50	30,000
Insurance, F.O.A., unemployment, etc.	21,000	10,200	.18	10,800
Depreciation	7,500	7,500		
Advertising	150,000	64,800	1.42	85,200
Total selling expense	$ 438,000	$ 204,000	3.90%	$ 234,000
Deductions from Sales				
Defective returns	$ 30,000		.50%	$ 30,000
Cash discounts	108,000		1.80	108,000
Allowances	54,000		.90	54,000
Total deductions from sales	$ 192,000		3.20%	$ 192,000
Total operating costs	$4,800,000	$ 840,000	66.00%	$3,960,000
Marginal income			34.00%	2,040,000
Break-even volume of operations		$2,470,000		
Profit before income taxes	$1,200,000			
Sales value of production	$6,000,000		100.00%	$6,000,000

EXHIBIT 3.

Note that this operating statement differs from a profit and loss statement in that "Sales value of production" was used instead of "Gross sales." The reason for this is that in most companies there is a difference between gross sales and sales value of production, represented by the annual change in finished goods inventory. If the change in inventory is substantial, an incorrect breakdown of operating costs would result from the use of gross sales as the base. However, having developed the fixed and variable cost breakdown on the basis of the sales value of production, a reconciliation can be made with gross sales if desired.

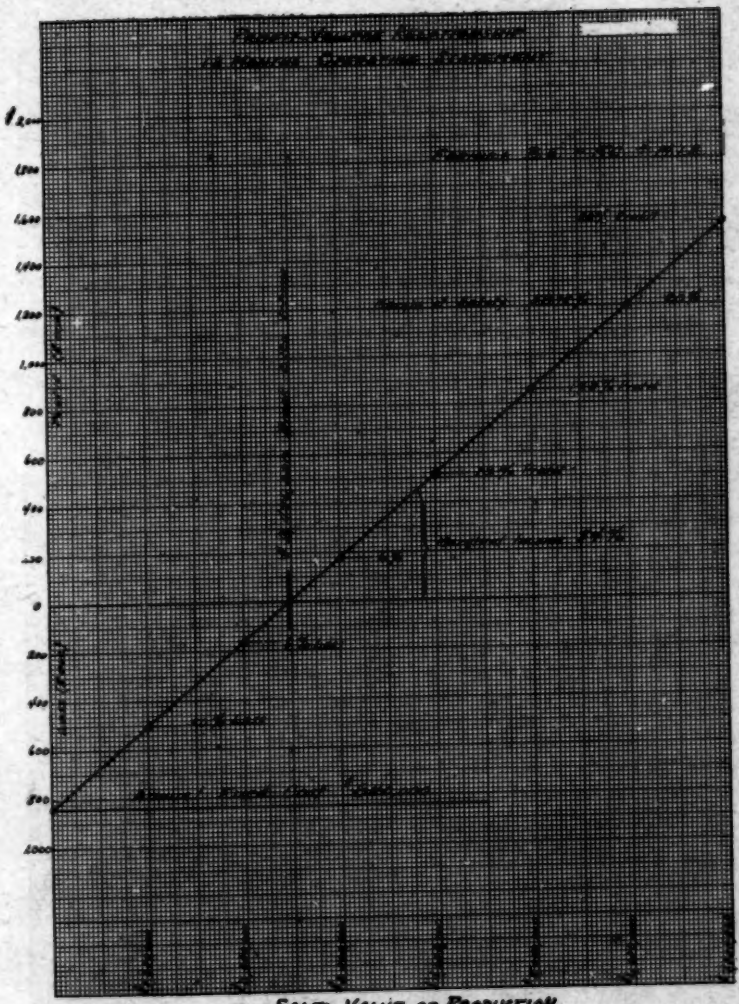
Exhibit 3 shows that the sales value of production during the year was $6,000,000; fixed operating costs were $840,000; and the variable operating costs represented 66 per cent of the sales value of production.

The margin between total variable costs and 100 per cent (the sales value of production) is 34 per cent. This is called the marginal income ratio. It may be defined as the *percentage* of income available for the payment of all fixed operating costs and profits. The marginal income or the *amount* available for the payment of all fixed operating costs and profits is the difference between total sales value of production and total variable costs. With a marginal income ratio of 34 per cent, the marginal income on $6,000,000 is $2,040,000. Since fixed costs are $840,000, the amount remaining for profit is $1,200,000.

The break-even point of operations, or the volume of production which will just cover fixed costs with no remainder for profit, will be the annual fixed operating costs of $840,000 divided by the marginal income ratio of 34 per cent, or $2,470,000.

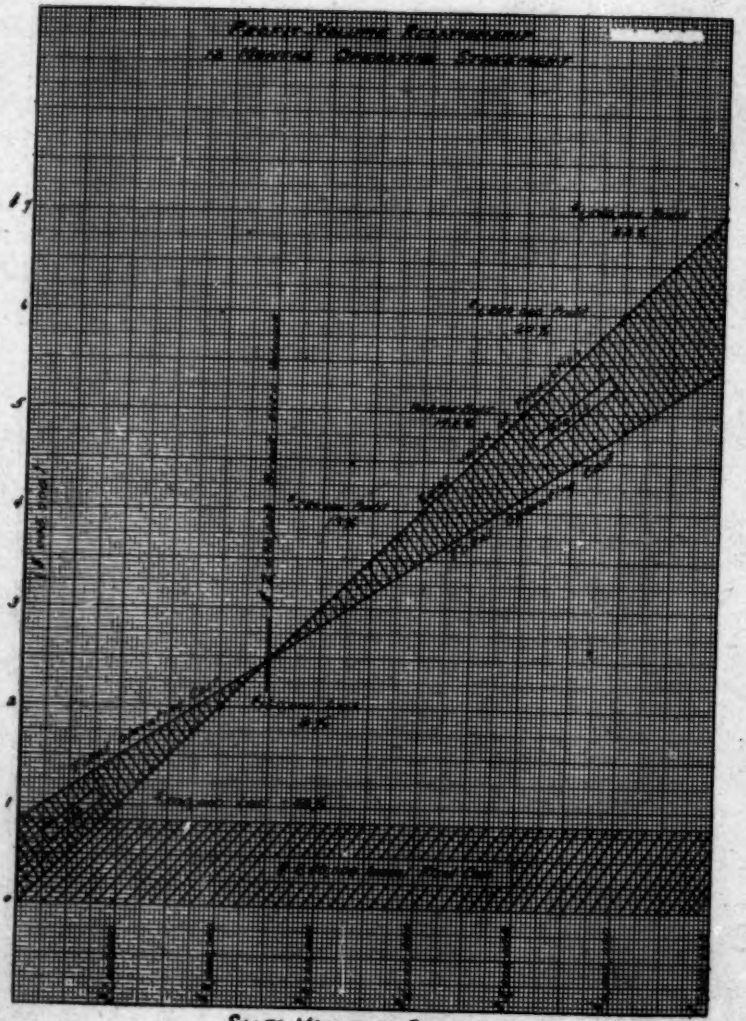
You can prove the accuracy of this technique of profit analysis by applying it to your own operations and checking the result against your annual profit and loss statement. It is well to remember, however, that since this is an analysis of the profit on production and not the profit on sales, if there has been any material change in inventory during the year it will be necessary to make adjustment for such change.

A graphic presentation of this profit-volume relationship is shown by Exhibit 4, which shows what the per cent profit would have been at varying volumes of operation above the break-even point, and what the per cent loss would have been at varying volumes below the break-even point. The margin of safety is 58.75 per cent at $6,000,000 of sales value. The margin of safety is the



SALES VALUE OF PRODUCTION

EXHIBIT 4.



SALES VALUE OF PRODUCTION

EXHIBIT 5.

per cent of sales in excess of the break-even point of operations.

A different graphic presentation of this same operating picture is shown in Exhibit 5. The reverse of these two graphs is the familiar unit cost curve shown on Exhibit 6. The change in unit cost comes from a change in the amount of *fixed cost* chargeable to the unit, i.e., a change in the volume over which fixed costs can be spread. Variable costs remain constant per unit of production. These three graphs, Exhibits 4, 5, and 6, illustrate marginal income analysis of profit-volume relationship, the modern tool for projecting costs and profits.

Laws of Costs and Profits

We are now ready to consider the laws of costs and profits, which should be clearly understood by management, controller, and cost accountant. These laws are—

1. A change in the amount of *fixed cost* changes the break-even point of operations, but not the marginal income ratio or the the progressive rate of net profit.
2. A change in the *variable cost* changes the break-even point, the marginal income ratio, and the progressive rate of net profit.
3. A change in the *selling price* has the same effect as a change in the variable cost.
4. The *marginal income ratio* is affected only by changes in selling price or variable cost.
5. A change in *both fixed and variable costs* changes to a still greater degree the break-even point, the marginal income ratio, and the progressive rate of net profit.
6. When the marginal income ratio is low—below 15 per cent—large changes in volume are required to produce any considerable change in profits. Conversely, as the volume falls below the break-even point, the accumulated losses will be at a relatively slow rate.
7. If large increases in volume are attained at a low marginal income ratio, additional working capital may be required faster than it is made available by the marginal income. In such case, a business with inadequate working capital is likely to encounter financial difficulties.
8. When the marginal income ratio is high—above 40 per cent—large profits and an easy cash position result from comparatively small increases in volume above the break-even

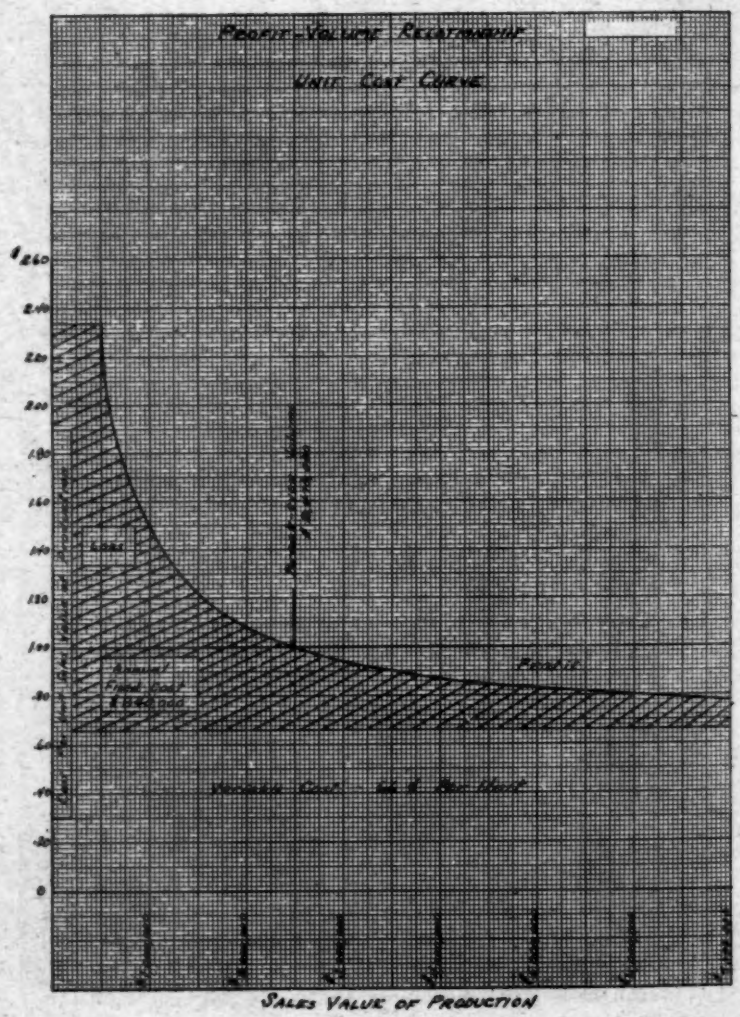

Profit-Volume Relationship
Unit Cost Curve
Sales Value of Production

Exhibit 6.

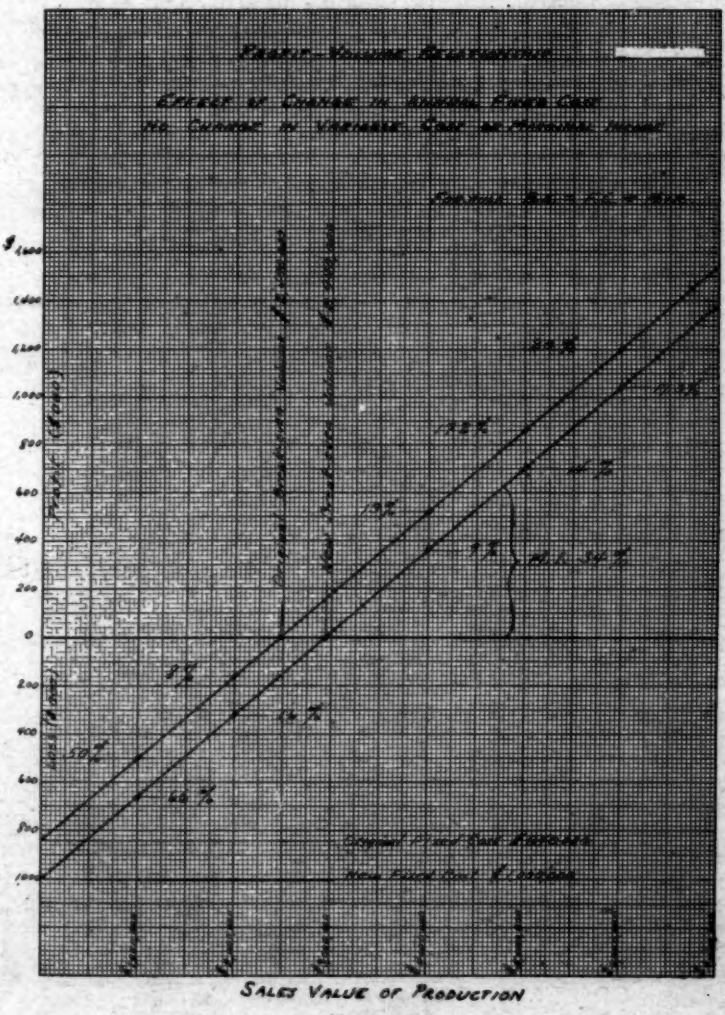

Profit-Volume Relationship
Effect of Change in Annual Fixed Cost
No Change in Variable Cost or Product Price
Present Annual Volume
Sales Value of Production

EXHIBIT 7.

point. Conversely, heavy losses will result from relatively small decreases in volume below the break-even point.

9. The size of the safety margin determines to a considerable extent the soundness of the business. A high safety margin means that the business can absorb a considerable drop in sales volume before showing a loss.

Change in Fixed Costs

These laws of costs and profits may be graphically illustrated. Thus, Exhibit 7 shows the effect of a change in the annual fixed cost, with no change in variable cost or marginal income ratio. Using the previous operating statement, Exhibit 3, we have increased the annual fixed cost by $160,000 to a total of $1,000,000. This increase in fixed cost moves the break-even volume over to $2,940,000. It now will require an additional $470,000 of sales, or an annual sales volume of $6,470,000 to return the same $1,200,000 profit.

To determine the additional sales value required to produce the same dollars of profit, we divide the increased fixed cost by the marginal income ratio:

$$\$160{,}000 \div .34 = \$470{,}000$$

A comparison of the revised operating statement with Exhibit 3 shows the following:

	Exhibit 3		*Revised*	
Sales value	$6,000,000	100.00%	$6,470,000	100.00%
Variable cost	3,960,000	66.00	4,270,000	66.00
Marginal income	2,040,000	34.00	2,200,000	34.00
Fixed cost	840,000	14.00	1,000,000	15.50
Profit	$1,200,000	20.00%	$1,200,000	18.50%
Break-even volume	$2,470,000		$2,940,000	

Note that whereas the dollar profits remain at $1,200,000 the percentage of profits to sales value of production has declined to 18.5 per cent. In order to retain the same 20 per cent profit ratio shown in Exhibit 3, sales must be increased to $7,150,000 so that fixed cost may remain at 14 per cent of sales value.

	Exhibit 3		*Revised*	
Sales value	$6,000,000	100.00%	$7,150,000	100.00%
Variable costs	3,960,000	66.00	4,720,000	66.00
Marginal income	2,040,000	34.00	2,430,000	34.00
Fixed cost	840,000	14.00	1,000,000	14.00
Profit	$1,200,000	20.00%	$1,430,000	20.00%
Break-even volume	$2,470,000		$2,940,000	

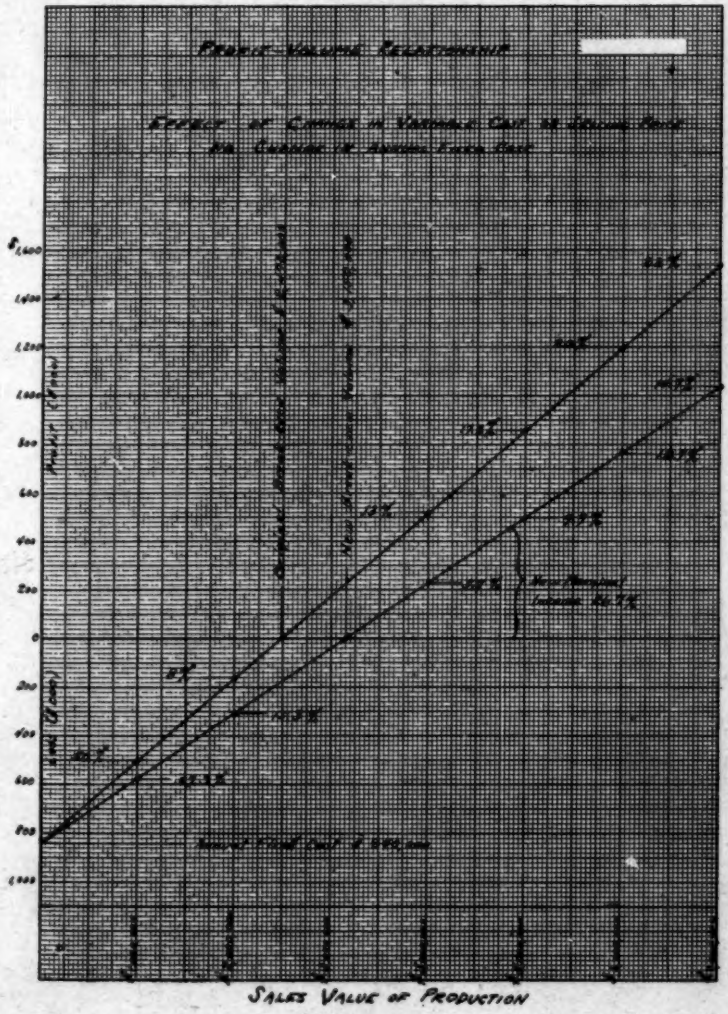


Exhibit 8.

Change in Variable Cost or Selling Price

Exhibit 8 shows the effect of a change in either variable costs or selling price, with no change in fixed cost. Again using Exhibit 3, the operating statement, we will increase the variable cost 11.1 per cent (which is the same as reducing selling price 10 per cent), giving a new variable cost ratio of 73.3 per cent. This increase in the variable cost ratio changes the break-even point, the marginal income ratio, and the progressive rate of net profits. The marginal income ratio is now 26.7 per cent (100.0 per cent — 73.3 per cent) and the new break-even point is $3,150,000, ($840,000 ÷ .267). Net profits now are 26.7 per cent of sales above the new break-even point.

The same effect on marginal income ratio and break-even point will result if selling price is reduced 10 per cent. An increase or decrease in selling price increases or decreases the base (100 per cent) from which variable costs are deducted (66 ÷ 90 = 73.3 per cent).

The effect either of these changes would have on Exhibit 3, the operating statement, is as follows:

1. Increase in Variable Cost—No Change in Fixed Cost

	Exhibit 3		*Increased variable cost*	
Sales value	$6,000,000	100.00%	$6,000,000	100.00%
Variable cost	3,960,000	66.00	4,400,000	73.30
Marginal income	2,040,000	34.00	1,600,000	26.70
Fixed cost	840,000	14.00	840,000	14.00
Profit	$1,200,000	20.00%	$ 760,000	12.70%
Break-even volume	$2,470,000		$3,150,000	

2. Decrease in Selling Price—No Change in Fixed Cost

	Exhibit 3		*Decreased selling price*	
Sales value	$6,000,000	100.00%	$5,400,000	100.00%
Variable cost	3,960,000	66.00	3,960,000	73.30
Marginal income	2,040,000	34.00	1,440,000	26.70
Fixed cost	840,000	14.00	840,000	15.60
Profit	$1,200,000	20.00%	$ 600,000	11.10%
Break-even volume	$2,470,000		$3,150,000	

It should be noted that the new marginal income ratio is 26.7 per cent of sales value, whether the change is the result of an increase in variable costs or a corresponding decrease in selling price.

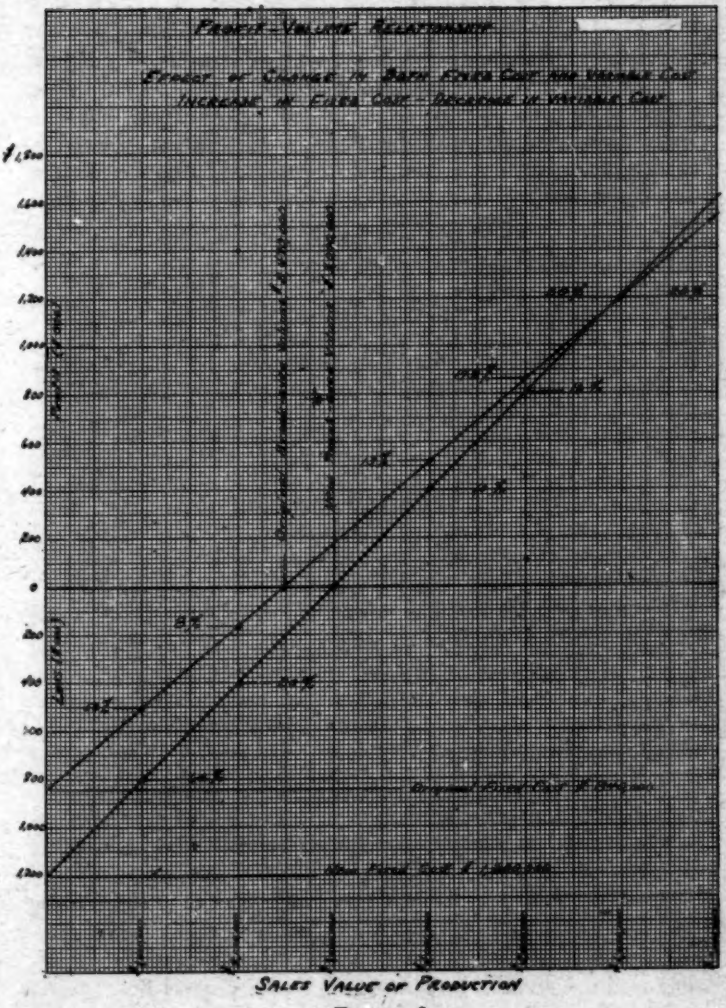

Profit-Volume Relationship
Effect of Change in Both Fixed Cost and Variable Cost
Increase in Fixed Cost - Decrease in Variable Cost
Sales Value of Production

Exhibit 9.

Also, in either situation, the break-even volume of operations has increased $680,000 to $3,150,000.

There is a marked difference, however, between the two situations in the amount of profit resulting from the sale of the same *quantity* of products. When variable costs increased 11.1 per cent, (which is the same as reducing selling price 10 per cent), but sales revenue remained the same, the profit, after covering fixed costs, was greater than when selling price was reduced 10 per cent. The reason was that the base, or selling price, against which the marginal income ratio was applied, was greater in the first example.

Changes in All Costs

Exhibit 9 shows the effect of an increase in fixed costs and decrease in variable costs. Using Exhibit 3, the operating statement, we have increased fixed costs to $1,200,000, but decreased the variable cost ratio to 60 per cent of selling price. These changes will affect the break-even point, the marginal income ratio, and the progressive rate of net profit. It will be seen that the break-even point has increased to $3,000,000, and the progressive rate of net profits, or net loss, is markedly different at the same volume of sales.

Product Analysis

It is now possible to break down the total costs and sales value into the product components. We could, if we so desired, go another step and break down each product into models or types. The only limit to which we can carry such analysis is the limitation of practicability. Since variable costs are the only costs that maintain a constant ratio to sales value of production, these are the costs that command first attention in product analysis. Fixed costs are a constant, general burden on operations whether or not we fully utilize the productive capacity of the plant, that is, whether we operate at high or low volume.

The variable costs of Exhibit 3 were a composite of the variable costs for the several manufacturing cost centers, the administrative and sales departments, and other charges. However, it is possible to determine the variable cost for each product line:

1. Materials and direct labor, on the basis of materials and labor standards.
2. Manufacturing burden, on the basis of production hours or dollars in the several cost centers of the plant.

3. Administrative, selling, and other variable charges, on the basis of the sales value of each product.

Making the breakdown of production and variable costs, we find that each product contributed a different percentage to the sales value of plant production and also to marginal income:

Product	*Sales value production*	*Variable cost*	*Per cent of sales*	*Marginal income*	*Per cent of sales*
A	$2,000,000	$1,200,000	60.0%	$ 800,000	40.0%
B	2,500,000	1,700,000	68.0	800,000	32.0
C	1,000,000	860,000	86.0	140,000	14.0
D	500,000	200,000	40.0	300,000	60.0
Total	$6,000,000	$3,960,000	66.0%	$2,040,000	34.0%
Fixed cost				840,000	
Profit				$1,200,000	
Break-even point	$2,470,000				

We find that the contribution toward fixed costs and profits varies from 14 per cent for Product C to 60 per cent for Product D. Obviously, Product C is not contributing its fair share of profits. However, it is contributing $140,000 toward payment of total fixed costs. Unless Product C can be replaced by some new product, with a higher marginal income ratio, or the productive machine capacity devoted to Product C can be utilized to increase production and sale of the other products, the company cannot afford to drop Product C, since it would mean decreasing net profits by $140,000.

Product C illustrates an important point in profit-volume analysis. All too frequently, cost accountants determine the profitableness of a product by distributing all costs, regardless of the volume of plant activity, and comparing such total costs with the sales price. Let us see what such a comparison would give for our products:

Product	*Sales value production*	*Total cost*	*Profit*	*Per cent profit*
A	$2,000,000	$1,455,000	$ 545,000	27.3%
B	2,500,000	2,061,000	439,000	17.6
C	1,000,000	1,042,000	—42,000	—4.2
D	500,000	242,000	258,000	51.6
	$6,000,000	$4,800,000	$1,200,000	20.0%

(Fixed costs have been distributed in the ratio of variable costs.)

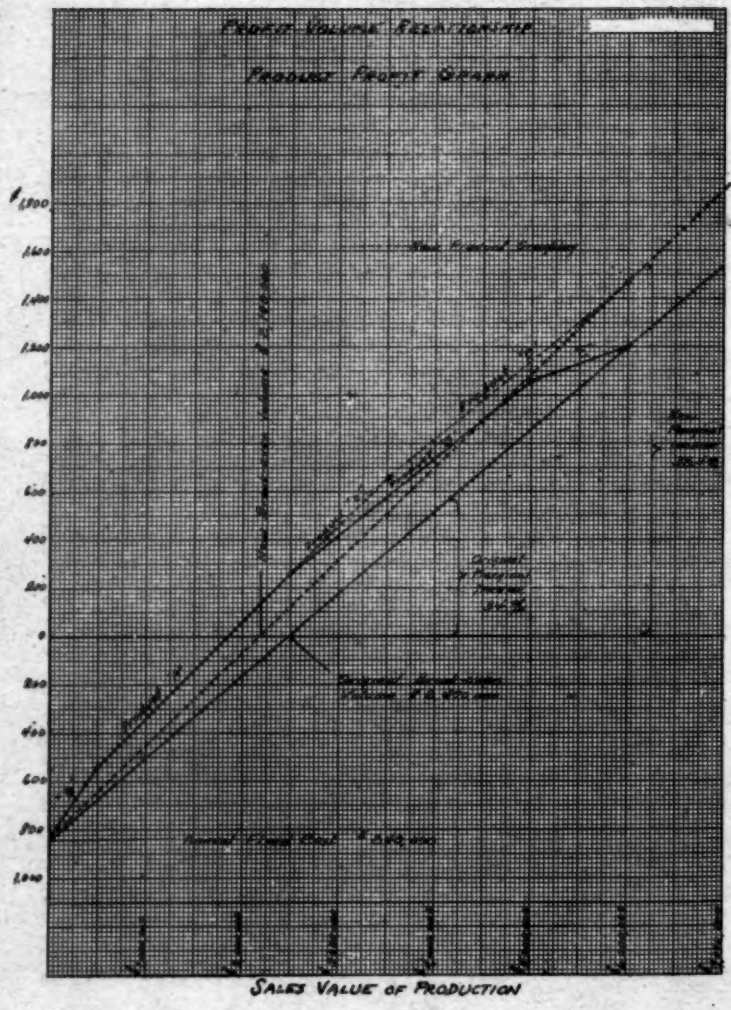

Profit-Volume Relationship
Product Profit Graph
Sales Value of Production

Exhibit 10.

An obvious danger in using this method of cost and profit analysis is that it shows Product C as a loss item which should be eliminated; whereas, it actually contributed $140,000 toward the company profit picture. Furthermore, this all too common method of cost distribution to products presents a confusing picture of profit-volume relationship, since a change in volume and mix of products will change the product cost relationship and profits. This confusion is eliminated when we follow the marginal income principle of analysis, whereby we set fixed costs apart and concentrate our attention on the margin between sales and variable costs.

Exhibit 10 shows a graphic analysis of the profit-volume relationship by product lines. Were it possible to substitute for Product C a new product that would contribute the same $1,000,000 sales and a marginal income ratio of 40 per cent, the same as Product A, the result would be a reduction in the break-even volume to $2,190,000, an increase in total marginal income ratio to 38.4 per cent, and a net profit increase of $260,000.

Conclusion

Although we could discuss many other ways in which this technique of profit analysis may be used, this illustration of its application to the mix of products is, in effect, the culmination or apex of the progressive steps we have taken:

1. Analysis of the fixed and variable elements of costs.
2. Determination of the break-even point of operations.
3. Effect on profits of changes in variable or fixed costs.

In presenting the results of profit-volume analysis and profit projection to administrative, sales, or production management, care should be used to see that the presentation is put into a form that can be readily understood by the individual to whom it is presented. This form may be a statement, graph, or combination of both. Some people quickly grasp facts when pictured by a graph who cannot interpret and retain them when presented in statement form; others do not like graphs but can interpret statements. Selection of the right medium for conveying the message is important.

PROPERTY RECORDS AND DEPRECIATION ACCOUNTING ON PUNCHED CARDS

by JOSEPH G. SIDAK, Tabulating and Payroll Supervisor,
Solar Aircraft Co.,
Des Moines, Iowa.

A REVIEW of the earlier concepts of the accounting profession discloses that, in general, little emphasis or importance was accorded property records and depreciation accounting. However, with the issuance of T.D. 4422 in 1934, by the Bureau of Internal Revenue, and subsequent requirements for more complete and accurate property and depreciation records, the accountant became cognizant of his responsibility in this field of accounting. The cost accountant proceeded to advance this field through his demands for departmental depreciation in order to develop accurate burden rates by cost centers, and through the data he required for the preparation of budgets and forecasts.

In view of the current accounting problems confronting industry, the engineer, and the cost accountant, this paper describes a procedure whereby property accounting and depreciation are accomplished mechanically by utilizing punched cards and tabulating equipment. This procedure can be applied to machinery and equipment, tools, buildings and additions, vehicles, land, laboratory equipment, office furniture and equipment, or any other capitalized item being depreciated or amortized.

Tabulating Punched Card

A tabulating card, Exhibit 1, for each asset is maintained in which the following information is punched:

1. Asset or equipment number.
2. Cost.
3. Date of installation.
4. Life in years.
5. Depreciation stop date.
6. Monthly depreciation amount.
7. Location (bay and floor number).
8. Net book value.
9. Condition (code).
10. Essential description of the asset.
11. Disposition (code).

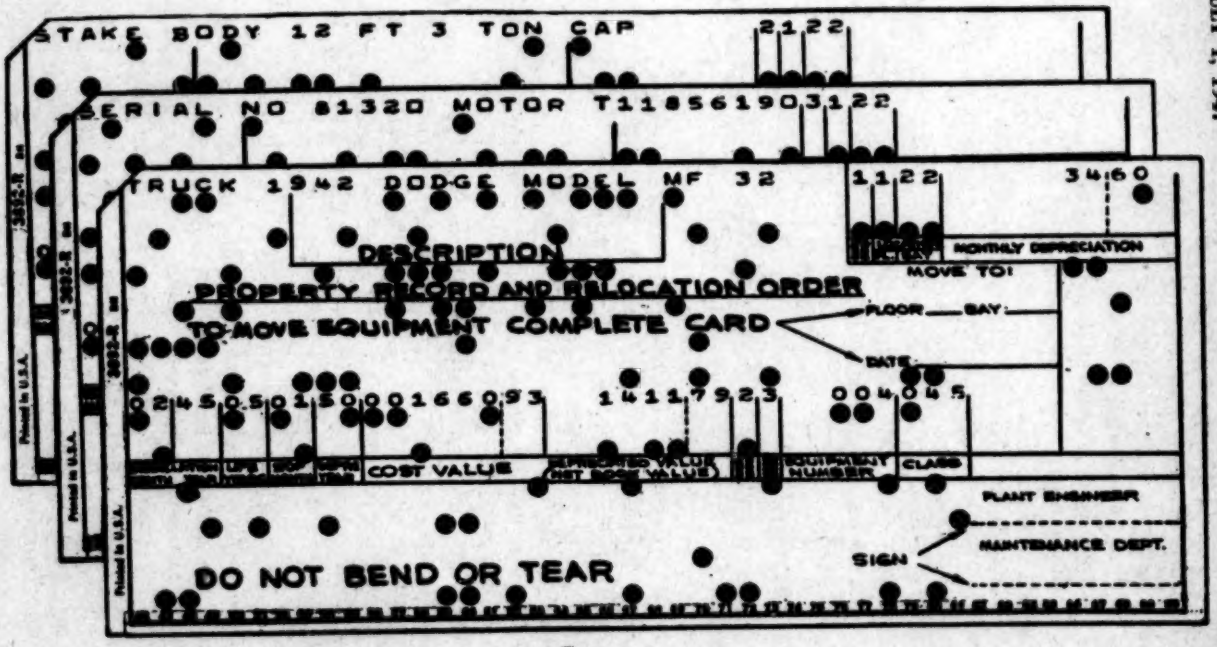

STAKE BODY 12 FT 3 TON CAP
2122
SERIAL NO 81320 MOTOR T11856190
3122
TRUCK 1942 DODGE MODEL MF 32
1122
3460
DESCRIPTION
MONTHLY DEPRECIATION
PROPERTY RECORD AND RELOCATION ORDER
MOVE TO!
TO MOVE EQUIPMENT COMPLETE CARD
FLOOR
BAY
DATE
0245050150001660933
14117923
004045
COST VALUE
EQUIPMENT NUMBER
CLASS
PLANT ENGINEER
MAINTENANCE DEPT.
SIGN
DO NOT BEND OR TEAR

EXHIBIT 1.

The "depreciation stop date" is the estimated date at which the asset's usefulness will have expired.

"Net book value" refers to the depreciated value.

"Condition (code)," a one-digit code number is used to disclose the condition readily—such as new, obsolete, need of repair, or remodeled.

"Disposition (code)," is used to identify equipment fully depreciated but still being operated; equipment on a two or three-shift basis; or other unusual usage or circumstance.

In case a more detailed description or other data is required (Exhibit 1), additional cards are punched containing supplementary information, and are numbered as to their sequence in describing the asset.

Plant Engineer's File

A duplicate card of a different color is automatically prepared for the plant engineer. This card is referred to as the "action card," and serves as his file record and also as the basis for a move order in case equipment is transferred to another location.

Upon request for transfer of a machine, the plant engineer removes from his file the appropriate card, indicates the new bay location, signs and forwards it to the maintenance foreman. The latter uses this form as a work order and at the completion of the move returns it to the plant engineer indicating that the relocation has been completed.

The plant engineer routes this "action card" to the tabulating department where the original card is removed from the file and automatically reproduced in its entirety, except for the new bay number, which is manually punched. The revised card is reproduced into a new "action card" containing the new location, and forwarded to the plant engineer for his file.

Acquisition of Capital Items

Acquisitions of capital items are handled through expenditure control accounts which are detailed by subsidiary numbers for each asset. These subsidiary accounts are maintained as cost records against which purchase price, freight, installation costs, and other expenses incidental to the respective assets are accumulated. Upon completion of the installation, the cost record is closed into the appropriate capital account. The cost record discloses all pertinent information necessary for the punching of a tabulating card. An

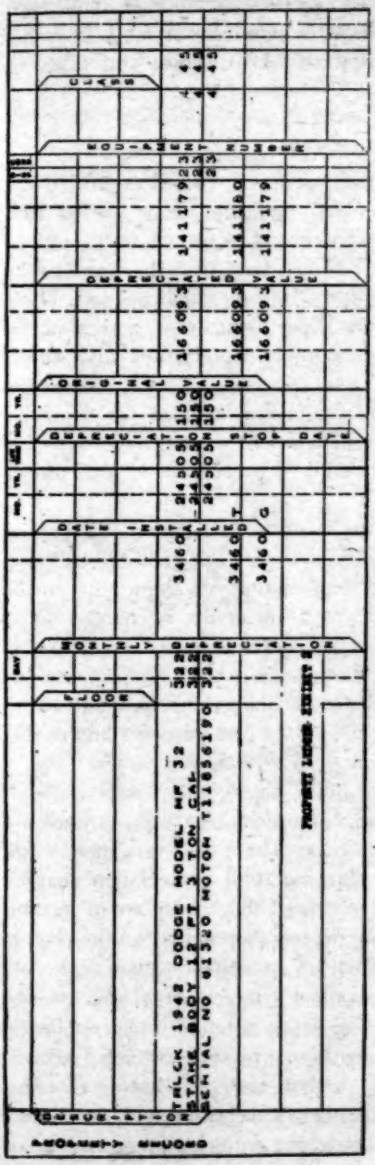


EXHIBIT 2.

equipment number is assigned to the asset by the financial division at the time the expenditure is approved, and all work orders covering the asset are identified by this number.

A special report of capital additions during the month is prepared for management by holding aside all cards covering additions during the month and tabulating them before preparing the regular property control reports.

Property Ledger

A tabulation of capital items in the property ledger is prepared each fiscal year or more frequently if desired (Exhibit 2). To assure proper department location references, and to uncover any theft or other losses, it is good policy to inventory the plant physically from time to time for comparison with a tabulation of the control cards. Tabulations also can be made projecting final depreciation date to serve as a guide to the plant engineer for replacement consideration, or to re-

port idle equipment that possibly can be sold. Another application for the control cards is a department summary of net book value to serve as a basis for distribution of insurance and taxes to proper cost centers.

Apportioning Depreciation

At the end of each month the property record control cards are automatically duplicated. The duplicate set is sorted into bay number order and with the use of a set of master cards containing both bay number and departments, the appropriate department is automatically punched into the duplicate set. These cards are then dated, sorted into department order, and tabulated securing departmental totals of "monthly depreciation" and "original cost." The "original cost" total serves as an audit against the general ledger proving that all assets are included for depreciation. The total depreciation by departments becomes the basis for a journal entry allocating monthly depreciation to the proper departmental expense accounts.

Prior to the preparation of the monthly distribution of depreciation, assets becoming fully depreciated are "selected out" by "stop depreciation date." Additional depreciation remaining, due to the fraction in using a monthly depreciation figure, is charged off at that time. The original card in the property record master file is coded "fully depreciated" and remains there until the property has been sold or salvaged. This feature enables the accountant, if desired, to continue depreciating assets for cost purposes and crediting nonoperating income, as practiced in some companies.

At the close of the fiscal year, the depreciation cards for each month are sorted into asset number order and tabulated, showing total depreciation taken for the year. These cards are then sorted by department and tabulated showing total depreciation charged to each department. Detailed reports of this nature are most valuable to the auditors in verifying depreciation entries to the reserve accounts and checking distribution for burden allocation.

Although a punched card control lends itself readily to the straight-line method of calculating depreciation, it is also applicable to the sum of the years, machine hours, production units, reduced balance, or annuity methods. Other methods, however, entail greater clerical work as the monthly depreciation must be recomputed each month or year. This would require a greater usage of

cards and key punching time. If advantages to be gained warrant this additional clerical detail, the practicability of mechanical preparation over manual methods would likewise apply.

Property or Equipment Number

It is a prerequisite of all tabulating techniques that there be a permanent code or number assigned each account, to control and sort by, and serve as identification. The same is true in property accounting. A property code number is assigned and serves to identify all records beginning with the expenditure authorization. This identification number is affixed to the machine in a visible position by the maintenance men at the time of installation.

The property numbers are assigned under a consecutive numbering system prefixed by a major code class to permit sorting assets into like groups, such as lathes, furnaces, desks, or electric motors. Where alphabetical facilities are not available on the tabulating equipment it may be well to consider using the full Government Standard Commodity classification, which suggests a coding to identify various types of machinery and equipment fully.

Disposition and Reports

A tabulating report is prepared for the plant engineer and the cost department for all assets being removed from the property ledger. The plant engineer uses this tabulation to remove the corresponding cards from his file. The cost department's copy serves as the basis for the preparation of appropriate entries, relieving the capital account, and adjusting the reserves. The original card in the property record control file is removed, associated with the cost record, and filed in a "dead" file.

Numerous reports for management can be quickly prepared by sorting and tabulating the various information contained on the property record control cards. It is possible to forecast accurately the depreciation expense of all existing assets. Attention can be called to equipment replacement problems by analyses using the estimated obsolescence or expiration of usefulness dates originally punched on the cards. Another valuable report is one prepared on machinery and equipment by classification to be used by the scheduling and planning departments for machine load studies.

Conclusion

The advantages gained by applying punched card methods to property accounting are

1. Current control of fixed assets.
2. Supporting details of depreciation.
3. Control of location and the apportioning of depreciation to proper cost centers.
4. Availability of records for various reports and forecasts.
5. Speed, accuracy, and economy over manual handling.

Companies which use punched-card equipment may profitably consider this application as a solution to one of their accounting problems, and in so doing utilize more fully their tabulating installations.

WANTED—ACCOUNTANTS' INDEX

A copy of the Accountant's Index, Sixth Supplement, issued by the American Institute Publishing Company and now out of print, is wanted by one of our members. It would be appreciated if any member with an available copy would communicate with National Headquarters.